HOW TO HANDLE IMBALANCE COSTS FOR VARIABLE RENEWABLE ENERGY GENERATORS

By USAID Energy Program

(for Comments for Georgian Stakeholders)

BACKGROUND

Because wind power projects cannot precisely predict what their generation output will be, on an hour-to-hour basis, the operator of the power system (Georgian State Electrosystem - GSE) has to keep some amount generation in reserve (spinning reserve). If there is too much or too little generation relative to demand, or too little or too much demand relative to generation, that is called an imbalance.

In a competitive power market, each generator is compelled to predict how much power they will generate, on a day-ahead basis, and on an hour-ahead basis. If the generator misses their predicted amount of generation, or if a consumer group misses their predicted amount of demand, then whoever misses their prediction is responsible to pay an imbalance charge based on prevailing market prices.

Imbalance charges can be manage able for most market participants. It is pretty easy for consumer to predict their demand, because many individual consumers are aggregated into large groups, and temperature and historical consumption make prediction easy. It is pretty easy for thermal generators and hydro projects to predict the amount of their generation. It is pretty easy for importers to predict the amount of their imports. In fact, wind and solar projects can predict very well the average generation over a long time. Even next-day wind and solar output is predicable for the day in total. However, the problem for wind and solar projects is in predicting the exact hour when a certain amount of generation will occur.

Hence wind and solar generators need special consideration with respect to imbalance charges. This memo explains in more detail the problem and sets forth the principles for resolution.

FINANCING REQUIREMENTS FOR NEW VARIABLE RENEWABLE ENERGY (VRE) GENERATION

Wind and solar power projects will not be financeable if they are subject to too much risk arising from any reason, including risk arising from imbalance charges.

All infrastructure investors, including International Financial Institutions (IFIs) require sufficient guarantees against risk to invest in VRE projects. These guarantees are covered mainly by long term 20-25 years Power Purchase Agreement (PPA), or other support mechanism such as Feed-in Tariff (FiT), Feed-in Premium (FiP), Contract for Difference (CfD). Other conditions include strict cost estimation and no experimental technology. IFIs are comfortable that the sun will shine and the wind will blow.

A well-accepted tariff calculation methodology is based on Levelized Cost of Energy (LCOE) and Weighted Average Cost of Capital (WACC).

The levelized cost of energy (LCOE) is a measurement used to assess and compare alternative methods of energy production. The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset, per unit of total electricity generated over an assumed lifetime.

Alternatively, the LCOE can be thought of as the average minimum price at which the electricity generated by the asset is required to be sold for in order to offset the total costs of production over its lifetime. Calculating the LCOE is related to the concept of assessing a project's Net Present Value (NPV). Similarly, to using NPV, the LCOE can be used to determine whether a project will be a worthwhile venture.

Simplified LCOE Formula and Calculation

$$\text{LCOE} = \frac{\sum \frac{(I_t + M_t + F_t)}{(1+r)^t}}{\sum \frac{E_t}{(1+r)^t}}$$

$$\text{LCOE} = \frac{\text{NPV of Total Costs Over Lifetime}}{\text{NPV of Electrical Energy Produced Over Lifetime}}$$

I_t = Investment expenditures in year t (including financing)
M_t = Operations and maintenance expenditures in year t
F_t = Fuel expenditures in year t
E_t = Electricity generation in year t
r = Discount rate
n = Life of the system

WACC is a calculation of a firm's cost of capital in which each category of capital is proportionately weighted. All sources of capital, including common stock, preferred stock, bonds, and any other long-term debt, are included in a WACC calculation.

A firm's WACC increases as the beta and rate of return on equity increase because an increase in WACC denotes a decrease in valuation and an increase in risk.

WACC Formula and Calculation

$$WACC = \frac{E}{V} \times R_e + \frac{D}{V} \times R_d \times (1 - T_c)$$

Where:
Re = cost of equity
Rd = cost of debt
E = market value of the firm's equity
D = market value of the firm's debt
V = E + D
E/V = percentage of financing that is equity
D/V = percentage of financing that is debt
Tc = corporate tax rate

BACKGROUND ON THE FOUR LEADING WIND PROJECTS IN GEORGIA

Last year Government of Georgia (GoG) approved Concept Notes for four Wind Power Plant (WPP) projects: Imereti 1 (100 MW), Nigoza (50 MW), Tbilisi (54 MW) and Kaspi (54 MW). Also, the Ministry of Finance of Georgia (MoF) approved a preliminary off-take tariff for all four wind projects, with the following conditions: off-take tariff at $6.5 ¢ / kWh, for 10 years period, 9 months per each year (excluding May, June and July).

Currently in Georgia there is one operating WPP. In 2016, the state-owned company Georgian Energy Development Fund (GEDF) developed first Wind Farm (WF) in Georgia Qartli. The installed capacity of the project is 20.7 MW, with the annual generation 90 ml kWh. The capacity factor of the farm is more than 45%. The full generated electricity is purchased by the state-owned enterprise Electricity Market Operator (ESCO), with the fixed off-take tariff $6.8 cents / kWh, for 10 years period, 12 months per each year.

Recently, the USAID Energy Program elaborated a study on "Pricing to Support Development of the Variable Renewable Energy in Georgia". In the study is developed a spreadsheet based simplified LCOE simulation model. Despite the limitations of the model, it can produce indicative information on the reference price for electricity: According to simulation scenario for wind, which uses technical parameters similar to Qartli WPP, the LCOE is 8.5 USD/kWh.

Data for Simplified LCOE on Wind Power Plant[1]

Lifetime of the Wind Power Plant - year	t	**25**
Investment Expenditures (including financing) - USD[2]	It	34,000,000
Capex + financing USD/kW		1,643
Operation and Maintenance - USD	Mt	4,788,902
O&M USD/kW/year[3]		60
kW/year (Installed Capacity)		20,700
Debt Service (USD/year)		3,546,902
Electricity Generation	Et	81,599,400
Discount Rate	r	10%
Capacity Factor		45%
Hours/Year		8,760
LCOE USD/MWH		**84.5**

Considering the above-mentioned calculation, the proposed electricity off-take tariff for the four leading wind projects of 6.5¢/ kWh is very likely barely feasible for bankability. This conclusion by USAID Energy Project was informally market-tested by its financing consultant Ankit Patel, and that negative conclusion was tentatively verified.

It is remarkable to note that none of the already-signed PPA projects in Georgia have an imbalance responsibility included in their PPA. Also, as a principle of competitive markets, it is essential to spread equal conditions on imbalance responsible parties to all generators who have the imbalance possibility. As the electricity price on the day-ahead market is variable, it is almost impossible to predict the cost of the imbalance charges, but it is sure that the additional imbalance responsibilities will increase imbalance costs.

An imbalance cost of unknown level will have a negative impact on project financing, and almost certainly this will be a “deal-killer.”

LEGAL FRAMEWORK

Imbalance charges are anticipated in the legal framework for setting up the competitive power markets in Georgia.

Purpose of the New Legislation with New Institutions and Regulations

The background and the framework of the recently-passed Georgian energy related legislation follow the EU standards and regulations. The premise is based on the Association Agreement signed by Georgian Government on June 2014 and the Accession to the Energy Community Treaty (EnCT) signed on October 2016. Thereby, Georgia undertook legally binding commitments to adopt core European Union (EU) energy legislation, the so-called "acquis communautaire”. The Treaty and its acquis evolve constantly to incorporate new sectors as well as update or replace older acts.

Imbalance and Balance Responsible Parties (BRP) in EU Standards

One of the key concerns is imbalance in electricity markets. *“**All market participants should be financially responsible for imbalances they cause in the system, representing the difference between the allocated volume and the final position in the market**”.*[4]

Imbalances mostly are settled by Transmission System Operators (TSOs) after the closure of the intraday market within the balancing market timeframe and within responsibility scheduling area or bidding zone. In real-time, the TSO activates the least-cost resources with the requested technical capabilities to fix imbalances between generation and consumption.

1.Simulation uses indicators (capacity and capacity factor) from the Qartli Wind Power Plant
2.Investment Expenditures include Capital Expenditures and all Financial Costs
3.Data from IRENA: Renewable Power Generations Costs in 2018
4 EU Directive 2019/943 on Internal Market for Electricity

Shorter-term fluctuations are managed by the TSO, who will ask operators to increase generation or reduce demand. The TSO will pay for these ancillary services and charge the BRP responsible for the imbalance.[5]

Balancing injections (supply) and offtakes (demand) of electricity from/to the grid is the responsibility of BRP.

A BRP is a market party or its representative responsible for imbalances. A BRP can be an individual generator or industrial consumer connected to the transmission grid or a portfolio of generators / consumers (balancing groups).

The imbalance measurement is done per scheduling area. In other words, the imbalance area equals the scheduling area. The only exception to this rule is the case of a central dispatching model where imbalance area may constitute a part of scheduling area.

It is extremely relevant to this matter that sufficiently high imbalance settlements, paid when a party is found to be unbalanced in real-time, should give an incentive for market participants to balance their output on the Intraday Market (IDM). If these price signals are not strong enough, market participants will not feel the need to trade on the IDM and liquidity will remain low.

Additionally, if Variable Renewable Energy Sources (VRES) were held responsible (preferably under the same rules as conventional units) for their imbalances, they would be forced to trade in the IDM. Also, transparent 'near-real-time' information about the system state is of crucial importance. If market participants have this information, they can estimate potential imbalance settlements and they will be strongly incentivized to balance their positions in the IDM, especially when it is highly needed from a system perspective. In brief, a well-functioning liquid IDM depends on well-designed imbalance settlement rules.[6]

Imbalance and Balance Responsible Parties (BRP) as per Existing Treatment in Georgia

The EU rules on imbalances are well-transferred into the Georgian energy legislation. In accordance with the new law on Energy and Water Supply, which envisages the key priorities and requirements of EU legislation, responsible for balancing of transmission system is TSO, which will ensure balancing in compliance with rules and conditions laid down by the law. Consequently, newly adopted law of Georgia on Energy and Water Supply establishes the definition of BRP – balancing responsible party. BRP appears group of market participants or their representative responsible for imbalances under the signed contract on balancing and settlement.

Calculation of balancing rete and balancing responsibility, as well as BRP rights and obligations are under the regulation on Market Rules, which will be adopted in four months after the adoption of Market Concept Design, which in turn defines the market structure and toles and responsibilities of market participants.[7]

TECHNICAL ISSUES FACED BY GSE

The Market Concept Design has yet to be settled, but under virtually any scenario, GSE will have new responsibilities and costs as it relates to balancing the system.

GSE must address two unique requirements: the need to maintain a near real-time balance between generation and load, and the need to adjust generation (or load) to manage power flows through individual transmission facilities.[8]

According the existing Georgian Network Rules, the maximum dynamic deviation of the frequency in the system should not exceed ± 0.8 Hz[9]. Also the Network Rules[10] sets the maximum dynamic deviation of the frequency in the system shall not exceed ± 1.5 Hz. The nominal frequency in the

5 EPRS Understanding Electricity Markets in EU
6 The EU Electricity Network Codes, 2019 edition
7 Law of Georgia on Energy and Water Supply, Dec. 2019
8 http://www.consultkirby.com/files/TM2004-291_Frequency_Regulation_Basics_and_Trends.pdf
9 Article 14 Network Rules
10 Article 40[1] Network Rules

transmission network shall be 50 Hz. However, in the case below, a frequency higher than 53.0 Hz is not allowed.

The dispatch licensee shall maintain the frequency within the following:

A. Under normal operating conditions: f = 50 ± 0.5 hertz - for at least 97% of the year;
B. In emergency conditions: 47 - 53 Hertz;
C. The maximum deviation from the nominal frequency value shall not exceed ± 0.8 Hz.

Whilst the above rules provide specific parameters of frequency for the system, another paragraph [11] under the chapter Network Rules regulating new connections sets specific range of frequency 0.2 Hz. for wind of solar power plants which VRE plants can't violate when operating in normal mode (i.e., non-emergency and frequency control mode).

VRE have special circumstances that make it challenging to adhere to these Network Rules. The wind speed is always fluctuating, and so is the power generated from Wind Turbines (WTs). The fluctuating and uncertain nature of wind may introduce several challenges in the maintenance of the power balance in a power system if the penetration level tending to be from low to high. As its depicted on the figure provided below the generation curve of WPP is not linear comparative as it would be in case of hydro or thermal power plant power plant.

According the Network Rules customers, C and D category Generators (More than 10 MW installed Capacity) and 220 kW AC SYNC Interconnection Transmission Lines are the main means for the provision of Ancillary / System services - Primary / Secondary and Tertiary reserves together with Voltage Regulation and black start of the system. Those are services important for proper functioning of the transmission network and defines electricity (capacity) quality of supply.

In case a WPP active power deviation causes a violation of the frequency or voltage parameters set by Network Rules, it will be handled through the deployment of Ancillary / System services by Georgian State Electrosystem (GSE).

GSE's Ten Year Network Development Plan (TYNDP) 2019-2029 indicates that after the implementation of balancing mechanisms, for the period 2021- 2025 the integration of new wind and solar power plants needs additional operating reserve of 260 MW upward which may be one of the units of Enguri Hydro Power Plant HPP and 30% of VRE installed capacity for downward Reserve.

In the nearest future the stability of the power system will remain a task associated with a system operator GSE; entity proposed to be responsible for the operation of Balancing Market. In the environment of new ongoing electricity market, Balancing Market is a market for the provision of System Services -probably same as currently offered by GSE as an Ancillary/System services. The terms and conditions for becoming a Balancing Service Provide (BSP) will be set by the GSE and approved by Georgian National Energy and Water Supply Regulatory Commission (GNERC).[12]

The example of Iberian electricity market MIBEL shows typical trading behavior of WPPs in the Day-ahead Market (DAM) and the IDM and utilization of a Numerical Weather Prediction model meteorological parameters forecast and wind power forecast for the mentioned purposes. In the Iberian Market WPP submit bids to DAM during day D and submit their deviations to the various sessions of the intra-day market. WPPs need to bid their expected active power in day-ahead and intra-day markets, based on forecasts that use time horizons between 18h and 42h (for DAMs), and between 2h and 7h (for intra-day markets), ahead of real-time operation.

In case when not disturbed with the Numerical Weather Prediction (NWP) prediction errors, the forecast accuracy and preciseness tend to increase when the forecast time horizon is decreasing. However, when for the newly commissioned wind farms nonexistence of experience on wind power forecast is the case, to employ several forecast service providers and benchmark their performance is a good approach to have a very accurate and precise forecasts in a 6 month to 1 year period.

[11] Article 24[1] Network Rules
[12] The Concept Design for the Georgian Electricity Market

Below provided is a list representing Ancillary / System Services under the full disposal of GSE Dispatch Licensee[13]

GSE Instruction for Ancillary / System Services

Frequency Containment Reserve (Primary reserve);	1. C and D category Generators (More than 10MW installed Capacity) reduce or increase 2. Customers reduce or increase 3. 220 kW AC SYNC Interconnection Transmission Lines reduce or increase	✓ Up to 2 second respond time ✓ Period of up to thirty (30) seconds after the frequency changes ✓ Capable to act up to 20 minutes
Frequency Restoration Reserve (Secondary reserve)	1. C and D category Generators (More than 10MW installed Capacity) reduce or increase 2. Customers reduce or increase 3. 220 kW AC ASYNC Interconnection Transmission Lines reduce or increase	✓ Reserve maybe either Positive or Negative ✓ 15 minutes from frequency disturbance ✓ Acting duration 2 hours
Replacement Reserve (tertiary reserve)	1. **C** and **D** category Generators (More than 10MW installed Capacity) reduce or increase 2. Customers reduce or increase 3. 220 kW AC SYNC Interconnection Transmission Lines reduce or increase	✓ Substitution of primary and Secondary reserves after 2 hour of frequency disturbance. ✓ First Step - Launched after 2 hours from Emergency and will work at list 24 hours. ✓ Second Step – Launched after 24 hours from Emergency and will work at list one year.
Voltage regulation	Coming later	Coming later
Black Start of the system		As of today, TSOs are able to provide black start using the following power plants: 1. Khrami-1 (JSC Khramhesi-1) 2. Zhinvali HPP (Georgian Water and Power Ltd) 3. Vartsikhe HPP (Vartsikhe 2005 Ltd) 4. Enguri HPP (Engurhesi Ltd) 5. Dariali HPP (JSC Dariali Energy) 6. Lajanuri HPP (JSC Energo-Pro Georgia) 7. Atsi HPP (JSC Energo-Pro Georgia)

Types of Reserves Required Depending the Category of the Power Plant

Category of the Power Plant	Installed Capacity limits (MW)	Voltage Regulation Ability	Requirements for Sustainability	Reserves			Black Start Ability
				Primary	Secondary	Tertiary	
A	<1.5	not necessary	not necessary	not necessary	not necessary		not necessary
B	1.5 to 10	necessary	necessary	not necessary	not necessary		upon agreement
C	10 to 30	necessary	necessary	necessary	upon agreement	upon agreement	necessary
D	above 30	necessary	necessary	necessary	necessary	Upon agreement	necessary

ECONOMIC AND POLITICAL ISSUES (EU ALIGNMENT, ENERGY COSTS)

Economic Considerations

Day-ahead, intraday and balancing and ancillary services markets are designed to ensure electricity trading in a competitive manner and reflect true value of electricity production/consumption. To ensure discipline in the market and increase motivation of power plants for meeting their declared commitments, i.e. minimize deviation of forecasted and delivered electricity, imbalance charges are introduced. Fair allocation of balancing costs is necessary for assigning incremental costs to the entities causing the deviation. Two fundamental balancing market requirements are economic efficiency and security of supply14. Economic efficiency can be assessed through cost allocation, balancing price, utilization and operational efficiencies.

[13] Instruction on provision of Ancillary/System services
[14] Reinier A.C. van der Veen, Rudi A.Hakvoort, The electricity balancing market: Exploring the design challenge, 2016

Balancing market designs differ across countries and are dependent largely on electricity system size, national generation characteristics, consumption patterns, transmission constraints, available balancing service providers and general trading market characteristics. Therefore, it is not surprising that balancing electricity costs are different across countries and specifically for VRE. According to the European Wind Energy Association[15] in most EU Member States where wind power has a share above 2% in annual generation (14 out of 18 Member States for which data was received) wind power generators are already balancing responsible in financial or legal terms. Ranges of incurred balancing costs for wind power generators are 2-3 €/MWh on average. However, in less developed electricity markets such as in Bulgarian and Romania, balancing costs borne by wind power generators seem to be arbitrarily high and possibly prohibitive for new installations. For example, in Bulgaria, the range is between 10 and 24€/MWh and in Romania, if not part of a large aggregator, wind power generators pay on average 8-10€/MWh. One can conclude that balancing market needs to satisfy economic efficiency criteria, which comes from experience and market maturity, otherwise true balancing costs might be over or under estimated.

Political Considerations

Utilization of local energy resources is declared as a main policy direction by GoG to address energy security. The main strategic document, Georgia Energy Strategy 2020-2030, describes potential of variable renewable energy sources of Georgia and underlines their importance towards fulfilling renewable energy targets. Utilization of Wind and Solar Power gained more interest in Georgia during recent years, while before the priority was given to utilization of hydro power resources. From 2008 state policy was to utilize firstly hydropower resources and afterwards gradually develop VRE. Reduction of electricity production costs from VRE, albeit marginally but changed attitude towards VRE development in Georgia. However still integration of larger amounts of VRE is subject to prior development of hydro dam projects in Georgia (TYNDP).

One can argue that diversification of local energy sources has not gained enough attention in terms that impact on increased energy security is not assessed properly. Firstly, diversification of source of energy is important inside country as well, since over reliance on hydro could potentially cause significant problems during the low hydrology period. Sunny days or windy days are not necessarily correlated with rainy days, therefore having diversified generation mix can better address changing realities. Secondly, too much attention is paid on short-term wholesale price “curbing” and it is mainly compared with the spot import price. These two prices are not comparable when it comes to true costs.

Benefits associated with variable renewable energy utilization in Georgia need to be considered thoroughly. Positive externalities that are associated with diversification of energy resources, increasing local employment, FDI, greenhouse gas emissions reductions and other direct or indirect benefits that are not reflected in electricity price shall be compared to the negative externalities, especially the increased cost of balancing. Without established balancing market, stabilized balancing prices and absence of proper forecasting system it is complicated to estimate the future balancing costs for VRE.

Therefore not to hinder development of VRE energy projects, GOG should establish different balancing responsibilities for VRE (at least on initial stage) compared to conventional power plants.

[15] https://www.ewea.org/fileadmin/files/library/publications/position-papers/EWEA-position-paper-balancing-responsibility-and-costs.pdf

VRE SUPPORT SCHEMES AND IMBALANCE COST METHODOLOGY

Support Schemes in VRE

According to a study conducted by USAID Energy Program[16], Georgia provides the lowest level of support to the Variable Renewable Energy projects in the Europe and Eastern Europe Region.

In Georgia, guaranteed period of support for the PPAs under discussion is nine months[17] per annum for ten years, while in the EU the average duration period of the support mechanism for VRE is full year for 15-20 years.

Existing support scheme price for wind project in Georgia (Qartli Wind Power Plant – 69 USD/MWh) is the lowest for both EU (highest in Greece - 185 USD/MWh; penultimate in Austria 92 USD/MWh)[18] and Eastern European region (highest in Belarus – 143 USD/MWh; penultimate in Armenia – 89 USD/MWh). The pricing for the PPA in discussion at rate of 65 USD/MWh will still be lowest provided for the wind power plant project in EU and Eastern Europe region.

Considering the international development of the VRE (transparent auctions, sizes of the project, level of support and other benefits), international financial institutions and foreign investors will be able to find more lucrative projects outside of Georgia for financing with less risks associated.

Imbalance Cost Methodology

In almost all markets, imbalances are managed by the system operators, who contract for reserve capacity to be called upon in real-time. The cost of these operations is usually recovered through grid fees and/or imbalance prices (penalties for deviating from schedule). Regulators determine the design of the imbalance settlement and the balancing power markets (e.g. procurement system, prequalification).

LEADING PRACTICES

Imbalance Settlement in Britain

In Britain, the settlement of imbalances is not maintained to recover costs but solely to incentivize BRPs to be in balance. All costs incurred in managing the power system (including reserve availability and utilization payments, reactive power and black start capabilities, accepted bids and offers in the balancing mechanism and the TSO's internal costs) are socialized via the Balancing Services Use of System (BSUoS) charge. This is paid by every supplier and generator pro rata. It is calculated for each settlement period by dividing the costs incurred by the amount of electricity consumed and fed in during the period. Fixed costs like availability payments are spread across the year. This gives a price per MWh for system services, which is multiplied by the amount of electricity fed in or consumed by each party to calculate their charge for that period.

Imbalance Settlement in Germany

Costs for availability (capacity payments) are allocated among consumers via grid fees, and the utilization payments are recovered through the imbalance costs that evert BRP pays (receives) for being out of balance. The imbalance price is calculated by dividing the TSO's net costs to utilize balancing power by the net balancing energy in each 15 minutes.

Imbalance Deviation Bands in US[19]

The imbalance is the difference between the actual wind power produced and the scheduled power during the hour, therefore Federal Energy Regulatory Commission (FERC) had defined three deviation bands for energy imbalances in Midwest Independent Transmission System Operator (MISO) region:

- **less than 1.5%** - is netted out on a monthly basis and settled at actual incremental/ decremental cost.

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[16] USAID Energy Program: "Pricing to Support Development of the VRE in Georgia"
[17] All months, except for June, July and August
[18] Prices are for the 3rd Quarter of 2018
[19] Read more https://www.nrel.gov/docs/fy07osti/40663.pdf

- **between 1.5% and 7.5%** - 10% penalty approach:
  - wind generator will be charged 110% of the system incremental cost[20] for the amount of energy under-delivered.
  - wind generator will be paid 90% of the system decremental cost[21] for the amount over-delivered.
- **Above 7.5% -** wind power is exempted.

According to FERC, within the ±1.5% deviation band and 10% penalty approach for imbalance outside the band, the annual wind plant revenues will be decreased by about 2% compared to the maximum revenues with no deviation band.

However, the tolerance bands differ among the regional transmission operators and can be up to 8%.

Imbalance Settlement in Belgium

To promote integration of RES in Belgium, there are different approaches available. In addition to the green certificate system existing, the wind power plants are opted for the priority dispatch. In addition, the wind projects have curtailment risks compensated starting from 2009 - thus the generators do not lose income and therefore do not have investment risks outstanding. The imbalance tolerance margin for the onshore wind projects is 10%. Higher level of imbalance is subject of 10% penalty approach by local TSO.[22]

[20] Actual hourly energy prices of the Midwest Independent Transmission System Operator
[21] Actual hourly energy prices of the Midwest Independent Transmission System Operator
[22] Balancing Management Mechanisms for Intermittent Power Sources - A Case Study for Wind Power in Belgium http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.459.3827&rep=rep1&type=pdf

PRINCIPLES FOR RESOLUTION

Promote competitive power market

The rationale to introduce competitive power markets is based on the idea that market forces of supply and demand decisions of producers and consumers, as compared with administrative or regulatory command shaping decisions of producers and consumers. Note that supply and demand decisions can be in the context of next day or many years, and everything in-between. Also, there is an issue of supply and demand for power, which is a flow (like income), and supply and demand for energy, which is a balance (like cash assets). The competitive power market should reward the most efficient and lowest cost choices for energy and power, in the long term and in the short term.

However, every jurisdiction that has competitive power markets also has other constraints and objectives. These constraints and objectives might relate to emissions, resource adequacy, amount of renewable energy, diversity of different technologies, transmission limitations, and other factors.

Georgia has committed to a competitive power market approach consistent with EU Third Energy Package and which is now a matter of Georgian law. In the short term this means having a regime of day-ahead trading and intra-day trading, and a clear framework for imbalance charges. In the long-term this means acquiring new generation on a competitive basis such as reverse auction.

Any decision about how to handle imbalance costs for variable renewable energy generators should respect the commitment to a competitive market approach.

Promote reasonable significant amount of wind and solar generation

Out of 4,000 MW of installed generation, Georgia has merely 20 MW of wind, i.e., one small pilot project. Installed solar is essentially zero. The penetration level of wind and solar in Georgia is, at this point in time, *de minimis*. A reasonable and significant amount of wind and solar energy generation is 10-20% of total energy, and indeed GSE's latest TYNDP allows for 330 MW of wind and solar installed capacity. The reason to install wind and solar is to diversify away from hydro, to increase domestic generation, to increase energy security, to positively impact climate change and to mitigate risk from climate change.

Any decision about how to handle imbalance costs for variable renewable energy generators should be the minimally invasive that still allows for successful development this reasonable and significant goal of 330 MW of wind and solar.

No "copy and paste" selectively from advanced markets

There is now on a global basis a large body of experience with selling variable renewable energy selling into competitive market environment. There are many ways to handle imbalance costs, but those many ways are executed across many different market conditions and frameworks.

Two main differences about market conditions and frameworks are: 1) markets are at different levels of maturity, and 2) markets have different sizes and compositions. Those two main differences – size and age - create significantly different risks for market participants. The older the market, the longer the track record, the more lessons learned, the more comfortable will be investors. Market size makes the difference that an individual generator's variability is not as much of a problem and should cause lower imbalance charges. The underlying conditions in different markets mean that the same rules in one place can be workable but, in another place, not workable.

Any decision about how to handle imbalance costs for variable renewable energy generators should account for all underlying conditions when comparing leading practices from advanced markets. There should be a solution that selectively grabs one practice without accounting for the context from which the practice is achieved.

Particularly and mainly, Georgia is at the very beginning of its inclusion of wind and solar projects and probably should not encumber these leading projects with conditions appropriate for mature markets with established balancing conditions and the track record to understand the risks.